INDOOR AIR QUALITY ASSESSMENT

Tile Investigation
Friedman Middle School
500 Norton Avenue
Taunton, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program
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Background/Introduction

At the request of Jeanine Anielo Flaherty, Director of the Taunton Health Department (THD), the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality concerns at the Friedman Middle School (FMS), 500 Norton Avenue, Taunton, MA.

The school was visited by Cory Holmes, Environmental Analyst of the Emergency Response/Indoor Air Quality (ER/IAQ) Program on October 17, 2002 to conduct an assessment of stained tile floor. Mr. Holmes was accompanied by W. Gerard Sanborn, Facilities Manager for the Taunton School Department, and for portions of the assessment Richard Faulkner, School Principal and Ms. Flaherty, Joseph Alberta and Henry Tartaglia of the THD.

The school is a two-story red brick building constructed between 1995-2001. It is currently in its second year of operation. Local school and health officials first reported a dark staining of vinyl floor tiles in May of 2002. Several floors were reportedly stripped with a buffing machine using porous pads and sealed with two coats of sealer and wax over the long holiday weekend of October 12-14, 2002. At the time of the BEHA assessment the staining had not returned.

Methods

Visual inspection for microbial growth was conducted on floor tiles. Water content of the vinyl floor tile was measured with a Delmhorst, BD-2000 Model, Moisture Detector with a Delmhorst Standard Probe. Moisture tests of vinyl floor tile were

conducted in both stained and unstained tile for comparison as well as in areas not affected (on both the first and second floors). Air tests for carbon dioxide, temperature and relative humidity using a TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

The school houses grades 5-8 and has a student population of approximately 980 and a staff of approximately 90. Tests were taken during normal operations at the school and results appear in Tables 1-2.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were below 800 parts per million parts of air (ppm) all areas surveyed, indicating adequate fresh air ventilation. Fresh air in classrooms is supplied by a unit ventilator (univent) system. Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building and return air through an air intake located at the base of each unit (see Figure 1). Fresh air and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located in the top of the unit. Univents were operating in all of the areas surveyed, with the exception of room 114. Obstructions to airflow, such as plants, books and other items stored on univents were seen in some areas. In order for univents to provide fresh air as designed, units must be activated while rooms are occupied and air diffusers should remain free of obstructions. The mechanical exhaust ventilation system consists of ceiling-mounted exhaust vents, which were operating during the assessment.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact

that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see Appendix I of this assessment.

Temperature measurements ranged from 70° F to 74° F, which were within the BEHA recommended comfort guidelines is all areas surveyed. The BEHA recommends that indoor air temperatures be maintained in a range of 70 ° F to 78 ° F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity in the building was in the lower end of the BEHA recommended comfort range in the majority of areas sampled. Relative humidity measurements ranged from 38 to 42 percent. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

As previously discussed, the assessment was requested due to occupant concerns of stained floor tiles believed to be possible mold growth. BEHA staff examined stained tiles throughout the first floor of the FMS, which appeared to be a gum-like substance

rather than staining (see Picture 1). The material accumulated on tiles did not appear to be microbial growth and no mold-type odors were detected (or reported by school/health officials). Accumulations appeared to be more prevalent in high traffic areas and classrooms than in low traffic areas (e.g. the art room, teacher's workroom and science lab). Stained tiles also appeared to be more prevalent in specific areas that had excess mastic leaking/oozing from around tile seams (see Picture 2).

Building staff reported that the ventilation system had been deactivated over the summer. Without dilution and removal created by the mechanical ventilation system, excess heat and moisture can build up inside the building. The accumulation of moist air can lead to condensation on floor tiles. It is possible that due to temperature extremes and moisture, tile mastic had softened. As moisture accumulates in tile seams, it comes in contact with tile cement, which can lead to swelling of the cement and loosening of the tile seal to the cement floor. Exacerbating this problem was the coating of the floor with several layers of wax during the summer prior to the opening of school, which effectively "trapped" moisture beneath tiles.

High relative humidity would appear to be the most likely cause of moisture in the building for a number of reasons:

- Walls, window frames and ceilings appeared to be free of water penetration, eliminating roof/window leaks as a potential moisture source.
- The school is equipped with gutters and downspouts that collect and direct rainwater into an underground drainage system, preventing water from pooling against/around the building.

- During the spring and summer of 2002, New England experienced a stretch of excessively humid weather during three periods in May, July and August. As an example, outdoor relative humidity at various times from 73 percent to 100 percent without precipitation from July 4, 2002 through July 12, 2002 (The Weather Underground, 2002).
- Water penetration from ground water through the slab beneath tiles is unlikely due to:
  - The water table reported by school and health officials is at least 8-10 feet below the slab of the building. The water level observed in an adjacent wetland was well below the slab level of the building (see Picture 3).
  - The damaged tiles appeared after one of the driest summers in New England on record, limiting the opportunity for rainwater to come in contact with the slab.
  - School officials reported that the foundation is equipped with a vapor barrier that would prevent the seepage of moisture from sub-slab areas through the floor.

To determine if affected tiles had higher moisture content compared to unaffected tiles, moisture tests were conducted. As described earlier in the **Methods** section of this report, the tips of a moisture detector probe were inserted into stained and clean tiles (see Pictures 4 & 5). Tiles that were stained had consistently higher moisture content than those that were not (see Tables). In classrooms where the material had been removed, the

tile surface where stains had previously been had a spotty appearance (see Picture 6), indicating likely water damage.

Conclusions/Recommendations

Without inspecting the building during the times of high relative humidity or removing tiles to examine conditions of the cement slab, it is difficult to conclusively confirm the source of moisture affecting floor tiles. However, the description of conditions by school officials, previous relative humidity and weather conditions reported over the past several months and the deactivation of the mechanical ventilation system over the summer, appear to most likely account for sources of moisture in the building. In view of the findings at the time of the assessment, the following recommendations are made:

1. Contact the tile manufacturer to get the best advice on how to remove staining/material and dry out moisture from beneath tiles. This may include:
    - Removing material by stripping off wax with a buffer.
    - Allowing tiles to dry out either naturally, by heat or with dehumidification, or possibly (low relative humidity during the heating season should facilitate drying).
    - Removing and reapplying water damaged tiles.
2. Consider removing several tiles in various areas to determine if visible moisture and/or microbial growth are present. If so, the removal of all affected tiles may be necessary followed by cleaning with an appropriate antimicrobial agent.

3. A ventilation engineer should be consulted to ascertain the appropriate methods that may be employed to reduce or eliminate condensation-generation during the summer months.
4. If moisture accumulation/damage to floor tiles in the building recurs, consideration should be given to having a building engineer examine possible remediation/prevention strategies.
5. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy independent of classroom thermostat control.

References

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SMACNA. 1995. IAQ Guidelines for Occupied Buildings Under Construction. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

The Weather Underground. 2002. Weather History for Westfield, Massachusetts, July 4, 2002 through July 12, 2002.
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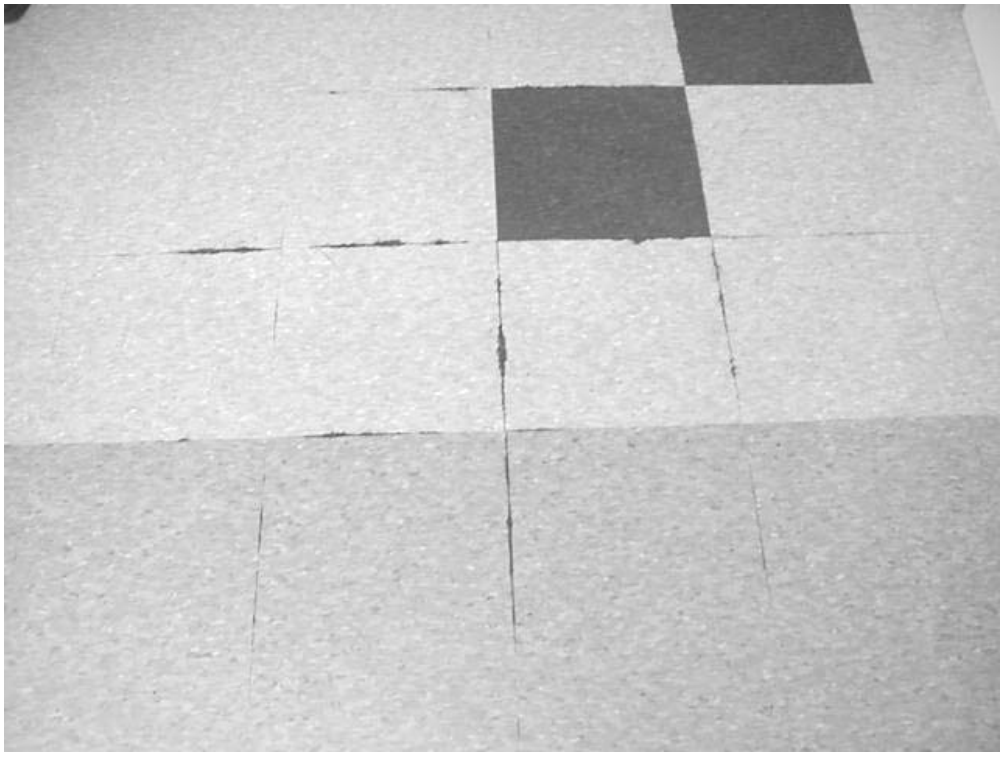
http://www.wunderground.com/history/airport/KBAF/2002/7/12/DailyHistory.html

Picture 1

Gum-like Substance on Floor Tiles as Indicated by Dark Spots

Picture 2

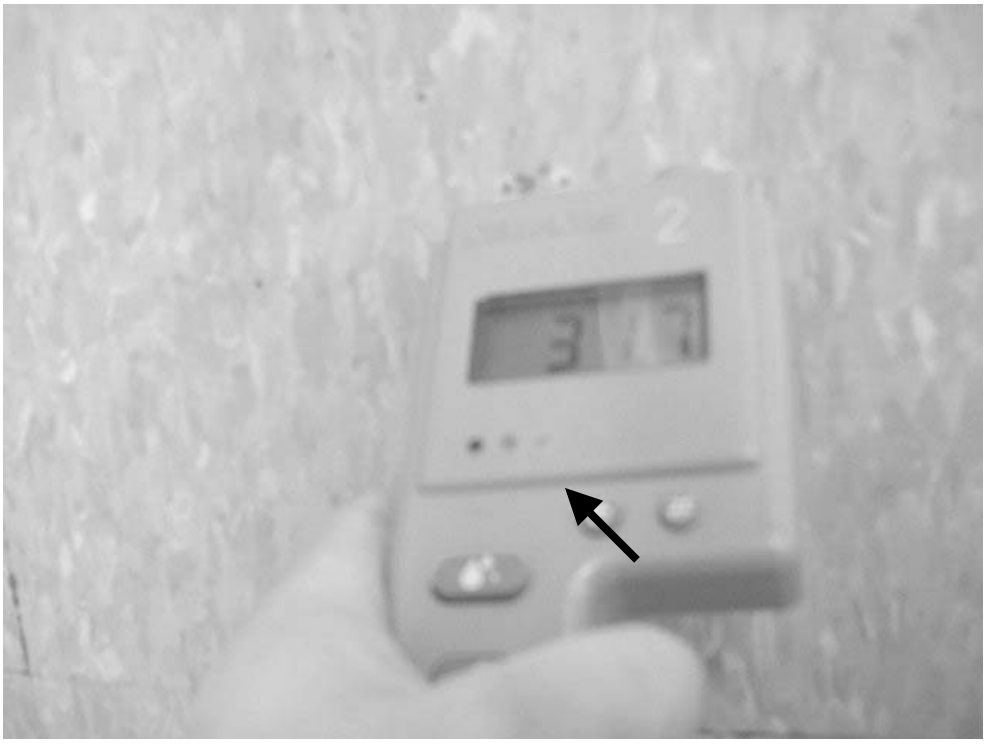


Gum-like Substance Observed around Floor Tiles

Picture 3

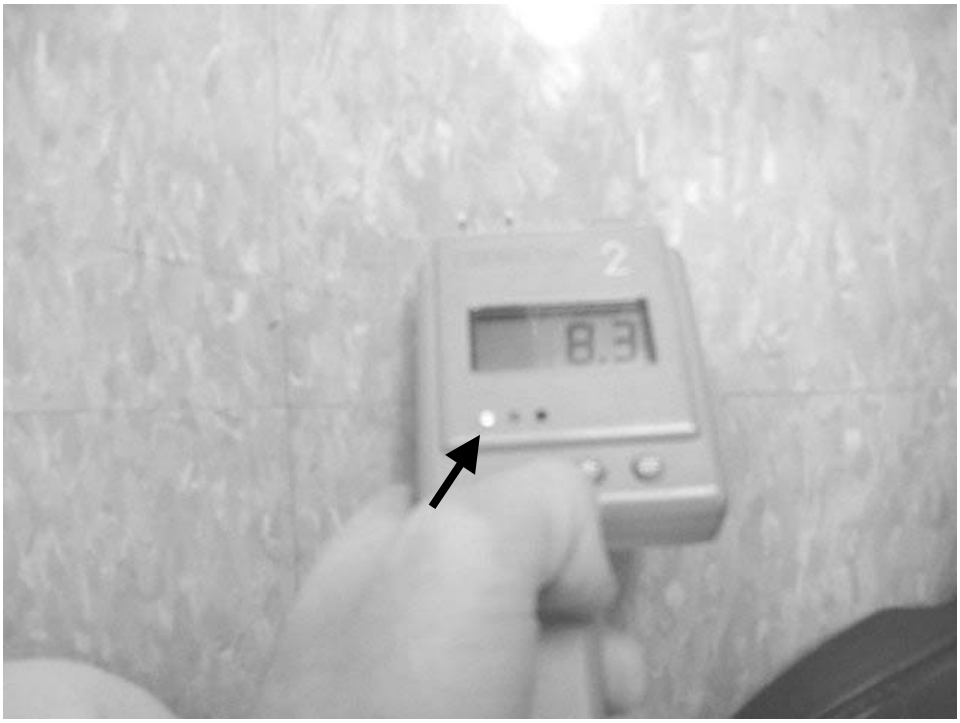
Adjacent Wetland located down hill from the Friedman Middle School, Note Water Surface Approximately 8-10 feet below Grade of School

Picture 4



Moisture Detector Inserted Into Stained Tile, Note Red Indicator Light was on Indicating High Moisture Content (Reading = 31.7 Percent)

Picture 5



Moisture Detector Inserted Into Unstained Tile, Note Green Indicator Light was on Indicating Low Moisture Content (Reading = 8.3 Percent)

Picture 6

Mottled Surface of Floor Tile That Had Stains Removed

TABLE 1

Location: Friedman Middle School, Taunton, MA Date: 10/17/2002

Location	CO_2 *ppm	Temp °F	RH%	Occupants in room	Windows openable	Ventilation		Remarks/ Moisture %
						Intake	Exhaust	
Background	481	61	43					Sunshine, clear skies, light breeze (westerly)
114	722	72	51	27	Y	Y	Y	Plant over univent (UV), door open
115 Lab								Tile with stains 21.7 % Tile without stains 8.0 %
119	738	72	40	30	Y	Y	Y	Tile with stains 26.3 % (near UV) Tile without stains 6.2 %(near UV) Tile with stains 30.6 % Tile without stains 0.0 %
103	537	70	38	20	Y	Y	Y	Tile with stains 29.8 % (interior side of class) Tile without stains 6.0 % (interior side of class) Tile with stains 20.0 % (center of class) Tile without stains 9.0 % (center of class) Occupants gone 5 min
Teacher's Lounge	608	70	40	3	Y	Y	Y	Tile without stains 6.0 % (near door) Tile without stains 8.0 % (center) Tile without stains 6.0 % (near ext wall)

*** ppm = parts per million parts of air**

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Location: Friedman Middle School, Taunton, MA Date: 10/17/2002

Location	CO_2 *ppm	Temp °F	RH%	Occupants in room	Windows openable	Ventilation		Remarks/ Moisture %
						Intake	Exhaust	
109								Tile with stains 40.0 % Tile without stains 6.0 %
209	757	72	39	26	Y	Y	Y	Tile without stains 0.0 % (North) Tile without stains 0.0 % (East) Tile without stains 0.0 % (South) Tile without stains 0.0 % (West) Tile without stains 0.0 % (Center)
224	786	74	42	33	Y	Y	Y	Tile without stains 0.0 % (North) Tile without stains 0.0 % (East) Tile without stains 0.0 % (South) Tile without stains 0.0 % (West) Tile without stains 0.0 % (West) Tile without stains 0.0 % (Center)

*** ppm = parts per million parts of air**

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